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(54) MAGNETIC RECORDING MEDIUM AND MAGNETIC STORAGE DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a magnetic recording medium having an enhanced orientation property of a magnetic film, fine and uniform crystal grains of the magnetic film and low noise.

SOLUTION: The magnetic recording medium has first base films 40 and 40' disposed on a substrate 40 directly or through a third base film, second base films 42 and 42' directly disposed thereon, the magnetic films 43 and 43' disposed further thereon and protective films 44 and 44' disposed further thereon and a cluster region having oxygen in quantity is dispersed at the boundary between the first and the second base films. The first base films consist of an alloy material which preferably contains two kinds of elements constituting the alloy material and having large difference between their standard free energy ΔG° of formation of oxide at 250° C.

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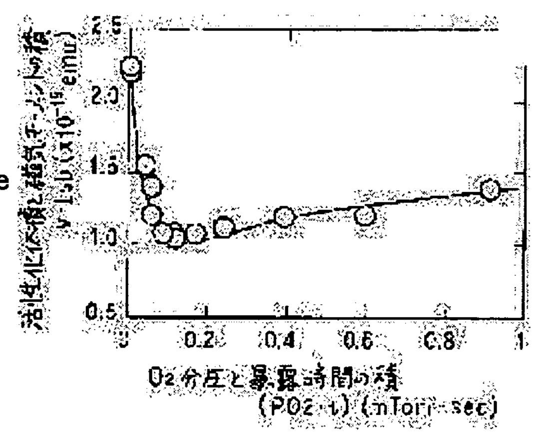

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CLAIMS

[Claim(s)]
[Claim 1] a substrate top -- the [direct or] -- the magnetic film arranged on the 1st ground film arranged through 3 ground films, the 2nd ground film directly arranged on this 1st ground film, and this 2nd ground film -- having -- the [the above-mentioned 1st ground film and] -- the magnetic-recording medium characterized by the cluster with many amounts of oxygen distributing to the interface of 2 ground films
[Claim 2] A magnetic-recording medium according to claim 1 and the magnetic head which is prepared corresponding to each side of this magnetic-recording medium, and consists of the Records Department and the reproduction section, The mechanical component for changing the relative position of the above-mentioned magnetic-recording medium and this magnetic head, Magnetic storage characterized by the bird clapper from the magnetic-head mechanical component which positions the above-mentioned magnetic head in a desired position, and the record regenerative-signal processor for performing output signal reproduction from the signal input and the magnetic head to the above-mentioned magnetic head.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the magnetic storage used for the auxiliary memory of a computer etc., the magnetic-recording medium used for the magnetic storage, and its manufacture method.
[0002]
[Description of the Prior Art] By advance of an information society, the increase of the amount of information treated daily is being enhanced. In connection with this, the demand of the high recording density to magnetic storage and the formation of mass storage capacity is strong. The electromagnetic-induction type magnetic head using the voltage change accompanying a time change of magnetic flux was used for the conventional magnetic head. This performs both record and reproduction with one head. On the other hand, the head the object for record and for reproduction is set aside, and the adoption of a compound-die head which used the high sensitivity magnetoresistance-effect type head by the head for reproduction is progressing quickly in recent years. With a magnetoresistance-effect type head, it uses that the electric resistance of a head element changes with change of the magnetic leakage flux from a magnetic-recording medium. Moreover, development of the still high sensitivity head which is produced in the magnetic layer of the type which carried out the laminating of two or more magnetic layers through the non-magnetic layer and which used a big magnetic-reluctance change (the huge magnetoresistance effect or the spin bulb effect) very much is also progressing. This uses that the relative direction of magnetization of two or more magnetic layers through the non-magnetic layer changes with the disclosure magnetic fields from a medium, and electric resistance changes with these.
[0003] Now, by the magnetic-recording medium put in practical use, the alloy which makes a principal component Co (es), such as Co-Cr-Pt, Co-Cr-Ta, and Co-nickel-Cr, is used as a magnetic film. These Co alloys are desirable in order to take the hexagonal structure (hcp structure) which makes c shaft orientations an easy axis, the crystal orientation, i.e., (11.0), the orientation, to which the c axis of this Co alloy takes field inboard as a magnetic-recording medium within a field which is reversed in a magnetic-film side and records magnetization. However, since this (11.0) orientation is unstable, even if it forms a direct Co alloy on a substrate, generally such orientation does not happen.
[0004] Then, when Cr (100) side which takes a body centered cubic structure (bcc structure) forms first the ground film of Cr which carried out orientation (100) using Co (11.0) side and adjustment being good on a substrate and grows Co alloy magnetic film epitaxially on it, the technique of making the orientation (11.0) the c axis of Co alloy magnetic film turned [orientation] to field inboard take is used. Moreover, in order to raise further the crystal-lattice adjustment in Co alloy magnetic film and Cr ground film interface, the second element is added to Cr, and the technique to which the lattice spacing of Cr ground film is made to increase is used. Co (11.0) orientation can increase further and coercive force can be made to increase by this. There is an example which adds V, Ti, etc. as such an example.
[0005] Moreover, as an element required for a raise in recording density, low noise-ization is mentioned together with a raise in the coercive force of a magnetic-recording medium. Since the above magnetoresistance-effect type heads have very high reproduction sensitivity, although it is suitable for high-density record, not only the regenerative signal from a magnetic-recording medium but the sensitivity to a noise becomes high simultaneously. For this reason, a magnetic-recording medium is asked for low noise-ization more than before. In order to reduce a medium noise, the crystal grain in a magnetic film is turned minutely, and it is known that it is effective to equalize the diameter of crystal grain etc.
[0006] Moreover, shock-proof improvement is mentioned as an important demand to a magnetic-disk medium. Especially, the magnetic disk unit to carried type information machines and equipment, such as a notebook computer, comes to be carried in recent years, and this shock-proof improvement has been a very important technical problem from a viewpoint of the improvement in reliability. The shock resistance of a magnetic-disk medium can be improved by changing to aluminum alloy substrate which gave nickel-P plating on the surface of the former, and using the glass substrate which carried out strengthening processing of the front face, or a glass-ceramics substrate. The glass substrate

is advantageous, when making small the surfacing spacing of the magnetic head and a magnetic-recording medium, since the front face is smooth compared with the conventional nickel-P plating aluminum alloy substrate, and it fits high recording density-ization. However, when a glass substrate is used, the problem of the adsorption gas on poor adhesion with a substrate, the impurity ion out of a substrate, or the front face of a substrate invading into Cr alloy ground film has occurred. To these, the cure of forming various metal membranes, an alloy film, and an oxide film between a glass substrate and Cr alloy ground film is made.

[0007] In addition, JP,62-293511,A, JP,2-29923,A, JP,5-135343,A, etc. are mentioned as technology relevant to these.

[0008]

[Problem(s) to be Solved by the Invention] It is known by reduction of a medium noise that detailed-izing of the crystal grain in a magnetic film and equalization are effective as mentioned above. however, sufficient electromagnetism from which about 1 gigabit per 1 square inch or the recording density beyond it will be obtained if a magnetic disk unit is made as an experiment combining an about 900 megabits [per 1 square inch of recording density] magnetic-recording medium, and a high sensitivity magnetoresistance-effect type head using the above-mentioned conventional technology -- the transfer characteristic was not obtained the case where a glass substrate is especially used as a substrate of a magnetic-recording medium -- the electromagnetism in a high track-recording-density field -- the result that the transfer characteristic was bad was obtained When this cause was investigated, the case where it was formed on a nickel-P plating aluminum alloy substrate had not carried out orientation of the Cr alloy ground film formed through various metals or those alloys seen by the direct or aforementioned well-known example on the glass substrate more strongly (100). For this reason, the crystal faces other than Co alloy magnetic film (11.0) grew up to be a substrate and parallel, and the amount of preferred orientation within a field of the c axis which is an easy axis was small. Thereby, coercive force declined and the reproduction output in high track recording density was declining. Moreover, when a glass substrate was used, the crystal grain of a magnetic film had ******ed compared with the case where aluminum alloy substrate is used, and particle-size distribution of crystal grain was also large 20% to about 30%. for this reason, a medium noise -- increasing -- electromagnetism -- the transfer characteristic deteriorated Moreover, it was not enough although there was when [whose diameter of crystal grain of a magnetic film became to some extent small] shown in JP,4-153910,A, even if it formed amorphous or the microcrystal film between the glass substrate and the ground film. furthermore, to reduction of a particle size distribution, an effect sees almost -- not having -- good electromagnetism -- the transfer characteristic was not obtained

[0009] The 1st purpose of this invention raises the stacking tendency of a magnetic film, attains detailed-izing and equalization of the crystal grain of a magnetic film, and is to offer the magnetic-recording medium of a low noise.

[0010] The 2nd purpose of this invention is to offer the manufacture method of such a magnetic-recording medium.

[0011] The 3rd purpose of this invention is to offer the magnetic storage of high recording density.

[0012]

[Means for Solving the Problem] In order to attain the 1st purpose of the above, the magnetic-recording medium of this invention a substrate top -- the [direct or] -- 3 ground films -- minding -- the 1st ground film -- arranging -- the 1st ground film top -- the 2nd ground film -- direct -- arranging -- the 2nd ground film top -- a magnetic film -- arranging -- the [this 1st ground film and] -- it is made to make the interface of 2 ground films distribute a cluster with many amounts of oxygen

[0013] In order to attain the 2nd purpose of the above, moreover, the manufacture method of the magnetic-recording medium of this invention a substrate top -- the [direct or] -- the 1st ground film being formed through 3 ground films, and in the atmosphere which ****** the 1st ground film PO2 and t (however, PO2 is the oxygen tension of atmosphere and t is **** time at this atmosphere) More than 1x10-6 (Torr and second) The 2nd ground film is directly formed on the 1st ground film which **(ed) between below 1x10-2 (Torr and second), and was **(ed) by this atmosphere, and a magnetic film is formed on the 2nd ground film.

[0014] In order to attain the 3rd purpose of the above, moreover, the magnetic storage of this invention The above-mentioned magnetic-recording medium and the magnetic head which is prepared corresponding to each side of a magnetic-recording medium, and consists of the Records Department and the reproduction section, It is made to constitute from a mechanical component for changing the relative position of a magnetic-recording medium and the magnetic head, a magnetic-head mechanical component which positions the magnetic head in a desired position, and a record regenerative-signal processor for performing output signal reproduction from the signal input and the magnetic head to the magnetic head.

[0015] As for the above-mentioned 1st ground film, it is desirable that it is the alloy which consists of two or more sorts of elements. When the element with which the plain-gauze fibers for plastering of oxidization differ is included in this alloy, the 1st ground film in the atmosphere of a certain time and a certain oxygen tension ****, The rich field of the element which is easy to oxidize makes a cluster with many amounts of oxygen locally, without making the uniform

oxide film which the front face followed in the field. In the crystal grain of the 2nd ground film which grows on this, it becomes the growth nucleus of the 2nd ground film, and it equalizes, and it is still smaller in the average crystal grain of a magnetic film, and this is presumed to be detailed-izing and the thing which can make the particle size uniform.
[0016] The ** type view of the cluster formed in the 1st ground film front face at drawing 1 is shown. Although this investigated structure for the sample which formed the monolayer of only a 68at%Co-24at%Cr-8at%W alloy film as the 1st ground film on the glass substrate, and formed the cluster in the front face further using the transmission electron microscope (transverse electromagnetic), it is a ** type view. Here, as it is indicated in drawing 1 as a cluster, it considers as the detailed thing which looks granular, and it is distributing uniformly at intervals of several nm. As a degree of the ease of oxidizing of an element, an oxide generation standard free energy serves as an index. In the alloy which builds the 1st ground film, the oxide generation standard-free-energy deltaG degree difference in the temperature of 250 degrees C More than 150 (kJ/mol O2) It is desirable to include two or more sorts of elements which are (however, choosing a low value most the above-mentioned (for example, Fe's having the oxide of Fe 2O3 and Fe3O4 grade) deltaG degree when an oxide's is the element whose two or more kinds exist). It is more desirable to include two or more sorts of elements which are more than 180 (kJ/mol O2), and it is most desirable to include two or more sorts of elements which are more than 200 (kJ/mol O2). Although there is especially no upper limit of this difference, in the combination of a common element, it is to about 1000.
[0017] An effect shows up by the oxygen supply of a minute amount by furthermore containing the element below minus 750 (kJ/mol O2) in this alloy for oxide generation standard-free-energy deltaG degree. Here, generation standard-free-energy deltaG degree in various elements, the oxide corresponding to it, and its temperature of 250 degrees C is shown in Table 1. This deltaG degree is deltaG degree which Coughlin showed, and the value read in the related view of temperature. This is shown in the 292nd page from the Japan Institute of Metals publication and the 291st page (new system metal new edition refinement section) (1964) of nonferrous metal refinement.
[0018]
[Table 1]

表 1

元素	酸化物	酸化物生成標準自由エネルギー ΔG^0 (kJ／mol O_2)
Co	CoO	-398
Mo	MoO_3	-410
W	WO_3	-473
Cr	Cr_2O_3	-666
Ta	Ta_2O_5	-724
V	V_2O_3	-737
Si	SiO_2	-783
Ti	TiO	-933
Zr	ZrO_2	-992
Al	Al_2O_3	-1005

As an alloy for the 1st ground films, at least one sort of elements chosen from the group of Mo, Ti, Zr, and aluminum and the alloy containing Cr are suitable from the point of the adhesion of a substrate and a film. If it is an alloy containing at least one sort of elements chosen from the group of Cr, Si, V, Ta, Ti, Zr, aluminum, and W, and Co as an alloy further for the 1st ground films, that this alloy is amorphous or since it becomes the diffusion barrier of impurities, such as an alkali element which invades into a film, from glass when a glass substrate is used, since an organization becomes precise that it is easy to become a microcrystal, it is effective. Here, it says that that the clear peak according being amorphous to an X diffraction is not observed or the clear diffraction spot by the electron diffraction, and a diffraction ring are not observed, but a halo-like diffraction ring is observed. Moreover, the diameter of crystal grain of a microcrystal is smaller than the diameter of crystal grain of a magnetic layer, and it means that a mean particle diameter consists of crystal grain 8nm or less preferably. Moreover, in the alloy for the above-mentioned 1st ground films, since it is related to the quantity of the above-mentioned growth nucleus and a between [5at% to 50at(s)%] grade has an effect in grain refining of the 2nd ground film, the content of an element with lowest oxide generation standard-free-energy deltaG degree is desirable, and its between [5at% to 30at(s)%] grade is more desirable.

[0019] Moreover, between the 1st ground film and a substrate, you may arrange the 3rd ground film. For example, when using a substrate as a glass substrate, the various metal membranes and alloy film which were shown in the conventional example, an oxide film, etc. can be used as the 3rd ground film.
[0020] What has bcc structures, such as high Cr alloy of crystal-lattice adjustment with Co alloy magnetic film, as the 2nd ground film is desirable. For example, Cr, Cr alloy, i.e., CrTi, CrV, CrMo, etc. can be used.
[0021] As for the thickness of the 1st ground film, it is desirable that it is the range of 20 to 50nm, and, as for the thickness of the 1st ground film, it is desirable that it is the range of 10 to 50nm.
[0022] Moreover, as for a magnetic film, it is desirable that it is the magnetic film the magnetic anisotropy has turned [magnetic film] to the inside of a field. Although the alloy which makes a principal component Co(es), such as Co-Cr-Pt, Co-Cr-Pt-Ta, Co-Cr-Pt-Ti, Co-Cr-Ta, and Co-nickel-Cr, can be used as such a magnetic film, in order to obtain high coercive force, it is desirable to use Co alloy containing Pt. Furthermore, a magnetic film can also consist of two or more layers through the nonmagnetic interlayer.
[0023] When coercive force which impressed and measured the magnetic field in the film surface as magnetic properties of a magnetic film is carried out to more than a 1.8K oersted and product Br-t of a residual magnetic flux density Br and Thickness t which impressed and measured the magnetic field in the film surface is made below into 140 Gauss Miquelon more than 20 Gauss Miquelon, since good record reproducing characteristics are obtained, in a recording density field 1 gigabits [per 1 square inch] or more, it is desirable. It becomes [the output in high recording density (200 or more kFCIs)] small that coercive force is under a 1.8K oersted and is not desirable. FCI (flux reversal per inch) is the unit of recording density here. Moreover, it becomes [the reproduction output in low recording density] small that the reproduction output in high recording density will decline if Br-t becomes larger than 140 Gauss Miquelon, and it is under 20 Gauss Miquelon and is not desirable.
[0024] In addition, when a magnetic film is constituted from two or more layers through the nonmagnetic interlayer, the thickness t of the magnetic film in calculation of the above-mentioned Br-t shall express the sum total of the thickness of each magnetic layer.
[0025]
[Embodiments of the Invention] Drawing 2 is typical explanatory drawing of an example of a sputtering system sheet membrane formation type [for producing a magnetic-recording medium]. An actual sputtering system has the main chamber 29 in the center, it taught the circumference and loculus 21, the 1st ground film formation room 22, a heat chamber 23, the oxidization room 24, the 2nd ground film formation room 25, the magnetic-film formation room 26, the protective coat formation rooms 27a, 27b, 27c, and 27d, and the ejection room 28 are circularly located in a line. Operation sent to the following loculus after processing a substrate by a certain loculus is simultaneously performed by each loculus. That is, what is necessary is to be able to process two or more sheets simultaneously by this sputtering system, and just to send a substrate to each loculus in order one after another. since it is desirable that protective coat formation performs by the low speed that there are four protective coat formation rooms 27a, 27b, 27c, and 27d -- every [of the thickness of the request by one loculus / a quadrant] -- it is for forming
[0026] By this sputtering system, put the substrate 20 of tempered glass into the preparation room 21 first, consider as a vacuum, and it is made to move to each loculus one after another through the main chamber 29, and processes as follows. It is **** to the atmosphere of the mixed gas of an argon and oxygen in the oxidization room 24 after forming a 60at%Co-30at%Cr-10at%Zr alloy at a room temperature and heating it at 270 degrees C as the 1st ground film. At this time, various **** time is changed to the mixing ratio of this mixed gas, and the atmosphere of this mixed gas. The laminating of the 75at%Co-19at%Cr-6at%Pt alloy was carried out for the 75at%Cr-15at%Ti alloy to order as a magnetic film as the 2nd ground film, respectively. Some are maintained at low temperature from 270 degrees C or it in the meantime. Furthermore, carbon is formed 10nm - 30nm in thickness as a protective coat.
[0027] As a result of changing **** time into the mixing ratio of above-mentioned mixed gas, and the atmosphere of mixed gas, as the volume change of activation v which shows a medium noise and alignment-correlation, and the product (v-Isb) of the magnetic moment Isb are shown in the oxygen tension PO2 of this atmosphere, and it to the product (PO2andt) of the **** time t at drawing 3 , it turns out that the minimal value is taken. here -- v-Isb -- journal OBU MAGUNETIZUMU and -- Magnetic It is explained to MATERIARUZU, the 145th volume (1995), and 255th page - the 260th page (J. Magn.Magn.Mater., vol.145, pp.255-260 (1995)). v-Isb is an amount corresponding to the smallest unit of flux reversal, and it is shown that a medium noise is so small that this v-Isb is small. Since this v-Isb is a physical amount, it does not depend a medium noise on record reproduction conditions, but can compare it objective. PO2 and t from which above-mentioned v-Isb becomes the minimum -- the [the 1st ground film or] -- although it changed by alloy composition and its composition ratio of 2 ground films, according to the various experiments, PO2 and t had the effect which lowers a medium noise below by 1x10-2 (Torr and second) more than 1x10-6 (Torr and second) When Co was especially contained in the 1st ground film, PO2 and t were effective by below 1x10-3 (Torr and

second) more than 1x10-6 (Torr and second).

[0028] In addition, by preparing lubricating film, such as a perfluoroalkyl polyether of adsorptivity, 1nm - 10nm in thickness further on a protective coat, a magnetic-recording medium is reliable and turns into a magnetic-recording medium recordable high-density.

[0029] Moreover, even if it performs the above-mentioned heating before the 1st ground film formation, there is same effect. Or even oxidization is performed at a room temperature, and after heating at 270 degrees C, you may form the 2nd ground film. This heating raises the crystallinity of a ground film, a magnetic film is formed into high coercive force, or is the common practice for making a low noise form, and is usually heated at 200 degrees C - about 300 degrees C.

[0030] Since sliding-proof nature and corrosion resistance can be improved if the film which consists of compounds, such as a carbon film which added hydrogen as a protective layer, and carbonization silicon or a tungsten carbide, and the mixed film of these compounds and carbon are used, it is desirable. Moreover, since the problem on which it can produce and cheat out of an unusual appearance salient on a protective-layer front face, or the touch area of ******, and a head and a medium can be reduced for irregularity on a front face, and a head adheres to it on a medium front face with heat treatment at the time of CSS operation is avoided using the target of a compound and mixture in forming detailed irregularity in a front face by carrying out plasma etching using a detailed mask etc. **** after forming these protective layers, it is desirable.

[0031] Moreover, as well as the case where a glass substrate is used when aluminum alloy substrate which plated nickel-P was used as a substrate, the effect that the crystal grain of a magnetic layer became detailed was checked.

[0032] When aluminum alloy substrate is used as a substrate, it is desirable to prepare the 3rd ground films, such as nickel-P, between a substrate and the 1st ground film as mentioned above further again. When a glass substrate is used as a substrate, it is desirable to prepare the various metal membranes and alloy film which may usually be used, and an oxide film between a substrate and the 1st ground film.

[0033] Drawing 6 is the mimetic diagram of the magnetic disk unit of one example of this invention, and its AA' line cross section. It is prepared corresponding to the mechanical component 65 which drives the magnetic-recording medium 64 in the record direction, and each field of the magnetic-recording medium 64, and consists of the magnetic head 61 which consists of the Records Department and the reproduction section, a magnetic-head mechanical component 62 which positions the magnetic head 61 in a desired position, and a record regenerative-signal processor 63 for performing output signal reproduction from the signal input and the magnetic head to the magnetic head. By constituting the reproduction section of the magnetic head from the magnetoresistance-effect type magnetic head, sufficient signal strength in high recording density can be obtained, and a magnetic disk unit with high reliability with recording density 1 gigabits [per 1 square inch] or more can be realized.

[0034] Moreover, when using the magnetic-recording medium of this invention by the magnetic disk unit, the interval (shield interval) of the shield layer of two sheets which sandwiches the magnetic-reluctance sensor section of the magnetoresistance-effect type magnetic head has desirable 0.35 micrometers or less. This is because resolution will fall if a shield interval is set to 0.35 micrometers or more, and the phase jitter of a signal becomes large.

[0035] Furthermore, two or more conductive magnetic layers which produce a big resistance change when the mutual magnetization direction changes the magnetoresistance-effect type magnetic head with external magnetic fields relatively, By the magnetic-reluctance sensor containing the conductive non-magnetic layer arranged between the conductive magnetic layer having constituted, and having used the huge magnetoresistance effect or the spin bulb effect Signal strength can be raised further and it becomes realizable [magnetic storage with high reliability with recording density 2 gigabits / per 1 square inch / or more].

[0036] <Example 1> drawing 4 is the cross-section perspective diagram shown typically [the magnetic-recording medium of this example]. The soda lime glass with which the chemical strengthening of the 2.5inch type was carried out was used for the substrate 40. The 1st ground film 41 which consists of a 60at%Co-30at%Cr-10at%Zr alloy with a thickness of 25nm on it, and 41' The 75at%Co-19at%Cr-6at%Pt alloy magnetic film 43 with a thickness of 20nm was formed for the 2nd ground film 42 which consists of a 85at%Cr-15at%Ti alloy with a thickness of 20nm, and 42', and the carbon protective coat 44 with a thickness of 10nm and 44' were further formed for 43'. Membranes were formed in baton 10 seconds, using single-wafer-processing sputtering-system mdp250A by the INTE back (Intevac) company as film formation equipment. A baton means time until it processes by the loculus and is sent to the following loculus from from immediately after having sent the substrate to a certain loculus from front loculus by the above-mentioned sputtering system. The chamber composition of this sputtering system is as having been shown in drawing 2 . All argon (Ar) gas pressure at the time of formation of each film was set to 6mTorr(s). The oxygen tension of the main chamber 29 under membrane formation is about 1x10-8 (Torr).

[0037] The 1st ground film is formed in the state where a substrate is not heated at the 1st ground film formation room

22. Heat to 270 degrees C at a lamp heater by the heat chamber 23, and it ** for 3 seconds after that at the oxidization room 24 in the atmosphere of pressure 5mTorr (quantity-of-gas-flow 10sccm) of 99%Ar-1%O2 mixed gas. Each above-mentioned film was formed in order on it after that at the 2nd ground film formation room 25, the magnetic-film formation room 26, and the protective coat formation rooms 27a, 27b, 27c, and 27d. The aforementioned PO2 and t at this time are equivalent to 5mTorrx0.01x3 second =1.5x10-4 (Torr and second). After forming to a carbon protective coat, what diluted the material of a perfluoroalkyl polyether system with fluorocarbon material was applied as lubricating film 45 and 45'.
[0038] In the <example 1 of comparison> above-mentioned example 1, the magnetic-recording medium produced on the same conditions as the above was made into the example 1 of comparison except not introducing the above-mentioned mixed gas at the oxidization room 24.
[0039] The coercive force of the magnetic-recording medium of this example 1 was higher than the magnetic-recording medium of the example 1 of comparison about about 300 oersteds at 2170 oersteds, and product Br-t of a residual magnetic flux density Br and the magnetic thickness t was 89 Gauss Miquelon. By the magnetic-recording medium of an example 1, since v-Isb decreased to 47% to 1.05x10-15 (emu) and 2.24x10-15 (emu) of the magnetic-recording medium of the example 1 of comparison, the medium noise also corresponded to this and it has reduced it in the abbreviation half. In the recording density field which evaluated the reproduction output, an example 1 and the example 1 of comparison are of the same grade, and S/N's of a medium have improved a decreased part of a medium noise.
[0040] When it actually included in the magnetic disk unit and the conditions of track-recording-density 161kBPI (bitper inch) and track density 9.3kTPI (track per inch) estimated record reproducing characteristics by the magnetoresistance-effect type magnetic head, the magnetic-recording medium of an example 1 had 1.8 times higher S/N to it of the example of comparison, and the equipment specification which is 1.6 gigabits per 1 square inch of field recording density was fulfilled enough. On the other hand, S/Ns ran short and it has not been satisfied [with the medium of the example 1 of comparison] of equipment specification.
[0041] When the structure of a Co-Cr-Zr alloy film was investigated for what formed the 1st ground film Co-Cr-Zr alloy 25nm in thickness on the glass substrate, and was performed to processing at an oxidization room on the same conditions as this example 1 using transverse electromagnetic (transmission electron microscope), the shade which reflected the detailed cluster corresponding to local oxidization of the 1st ground film front face in the transverse-electromagnetic image was observed. A path is several nm and this cluster is about formed in several nm pitch uniformly. The ** type view of this transverse-electromagnetic image is shown in drawing 1 .
[0042] Moreover, as a result of measuring the X diffraction of the magnetic-recording medium of this example 1, and the magnetic-recording medium of the example 1 of comparison, the diffraction pattern shown in drawing 5 was obtained. When 50nm of monolayers of only the Co-Cr-Zr alloy of the above-mentioned 1st ground layer was formed on the above-mentioned glass substrate on the same above-mentioned membrane formation conditions and the X diffraction was measured, the clear diffraction peak was not seen. In the diffraction pattern of the magnetic-recording medium of the example 1 of comparison, since the CrTi (110) peak of the body centered cubic structure (bcc structure) of the 2nd ground film laps with the CoCrPt (00. 2) peak of the hexagonal close packed structure (hcp structure) from a magnetic film, these both discernment is also impossible for it. However, anyway, orientation of the 2nd ground film is not carried out strongly (100) like the magnetic-recording medium of an example 1, but it serves as a mixed phase of two or more crystal grain from which orientation differs. For this reason, the Co-Cr-Pt alloy crystal in a magnetic film has also taken various crystal orientation, and two or more diffraction peaks are seen from a Co-Cr-Pt magnetic film.
[0043] On the other hand, in order that the magnetic-recording medium of an example 1 may not show a diffraction peak by the Co-Cr-Zr alloy monolayer of the 1st ground film as mentioned above, the diffraction peaks in drawing are the CrTi (200) peak of the bcc structure from the 2nd ground film, and a CoCrPt (11.0) peak of the hcp structure from a Co-Cr-Pt magnetic film. From this, the Cr-Ti alloy of the 2nd ground film formed on the Co-Cr-Zr alloy layer of amorphous structure takes orientation (100), and it turns out that the Co-Cr-Pt magnetic film on it has taken orientation (11.0) by epitaxial growth. For this reason, the component of the field inboard of the c axis which is an easy axis of a Co-Cr-Pt alloy becomes large, and good magnetic properties are obtained.
[0044] Furthermore, when transverse-electromagnetic observation of a magnetic film was performed, the average crystal grain size of the Co-Cr-Pt alloy of this example 1 is 10.8nm, and had turned minutely compared with 16.2nm of that of the example 1 of comparison. Moreover, since a clear hysteresis curve was not obtained when magnetization measurement of the Co-Cr-Zr alloy monolayer of the aforementioned monolayer was performed, it is thought that this alloy film is nonmagnetic.
[0045] The magnetic-recording medium was produced with the same film composition as the <example 2> above-mentioned example 1. The alumino silicate glass to which the chemical strengthening of the 2.5inch type was carried out was used for the substrate. The carbon protective coat with a thickness of 10nm was further formed [the 2nd ground

film which consists of a 80at%Cr-20at%Ti alloy with a thickness of 25nm the 1st ground film which consists of a 62at% Co-30at%Cr-8at%Ta alloy with a thickness of 40nm on it] for the 72at%Co-18at%Cr-2at%Ta-8at%Pt alloy magnetic film with a thickness of 23nm. Membranes were formed in baton 9 seconds using the single-wafer-processing sputtering system same as film formation equipment as an example 1. All argon (Ar) gas pressure at the time of formation of each film was set to 6mTorr(s). The oxygen tension of the main chamber under membrane formation is about 5x10-9 (Torr).

[0046] The 1st ground film was formed in the state where a substrate is not heated at the 1st ground film membrane formation room, it was heated to 250 degrees C at the lamp heater by the heat chamber, was **(ed) for 3 seconds at the oxidization room using 98mol%Ar-2mol%O2 mixed gas in the atmosphere of gas pressure 4mTorr (quantity-of-gas-flow 8sccm) after that, and formed each film on it. This is equivalent to 4mTorrx0.02x3 second =2.4x10-4 (Torr and second) by the above-mentioned PO2 and t. After forming to the above-mentioned carbon protective coat, the same lubricating film as an example 1 was applied.

[0047] In the <example 2 of comparison> above-mentioned example 2, the magnetic-recording medium produced on the same conditions as the above was made into the example 2 of comparison except not introducing the above-mentioned mixed gas at an oxidization room.

[0048] The coercive force of the magnetic-recording medium of this example 2 was higher than the magnetic-recording medium of the example 2 of comparison about about 200 oersteds at 2640 oersteds, and product Br-t of a residual magnetic flux density and magnetic thickness was 85 Gauss Miquelon. By the magnetic-recording medium of an example 2, since v-Isb decreased to 54% to 0.98x10-15 (emu) and 1.81x10-15 [of the example 2 of comparison] (emu) of that, the medium noise also corresponded to this and it has reduced it in the abbreviation half. In the recording density field which evaluated the reproduction output, an example 2 and the example 2 of comparison are of the same grade, and S/N's of a magnetic-recording medium have improved a decreased part of a medium noise. When it included in the magnetic disk unit and the conditions of track-recording-density 210kBPI and track density 9.6kTPI estimated record reproducing characteristics by the magnetoresistance-effect type magnetic head, compared with it of the example 2 of comparison, the magnetic-recording medium of an example 2 had 1.3 times higher S/N, and fulfilled enough the equipment specification which is 2.0 gigabits per 1 square inch of field recording density. On the other hand, S/Ns ran short and it has not been satisfied [with the magnetic-recording medium of the example 2 of comparison] of equipment specification.

[0049] The magnetic-recording medium was produced with the same film composition as the <example 3> above-mentioned example 1. The alumino silicate glass to which the chemical strengthening of the 2.5inch type was carried out was used for the substrate. The carbon protective coat with a thickness of 10nm was further formed [the 2nd ground film which consists of a 80at%Cr-15at%Ti-5at%B alloy with a thickness of 25nm the 1st ground film which consists of a 85at%Cr-15at%Zr alloy with a thickness of 30nm on it] for the 72at%Co-19at%Cr-1at%Ti-8at%Pt alloy magnetic film with a thickness of 22nm. Membranes were formed in baton 8 seconds using the single-wafer-processing sputtering system same as film formation equipment as an example 1. All argon (Ar) gas pressure at the time of formation of each film was set to 5mTorr(s). The oxygen tension of the main chamber under membrane formation is about 3x10-9 (Torr).

[0050] Especially the 1st ground film was formed at the 1st ground film membrane formation room without heating a substrate, it was heated to 240 degrees C at the lamp heater by the heat chamber, was **(ed) for 2 seconds at the oxidization room using 79mol%Ar-21mol%O2 mixed gas in the atmosphere of gas pressure 3mTorr (quantity-of-gas-flow 6sccm) after that, and formed each film on it. This is equivalent to 3mTorrx0.21x2 second =1.3x10-4 (Torr and second) by the above-mentioned PO2 and t. After forming to the above-mentioned carbon protective coat, the same lubricating film as an example 1 was applied.

[0051] In the <example 3 of comparison> above-mentioned example 3, the magnetic-recording medium produced on the same conditions as the above was made into the example 3 of comparison except not introducing the above-mentioned mixed gas at an oxidization room.

[0052] The coercive force of the magnetic-recording medium of this example 3 was higher than the magnetic-recording medium of the example 3 of comparison about about 200 oersteds at 2680 oersteds, and product Br-t of a residual magnetic flux density and magnetic thickness was 69 Gauss Miquelon. By the magnetic-recording medium of an example 3, since v-Isb decreased to 60% to 0.89x10-15 (emu) and 1.44x10-15 [of the example 3 of comparison] (emu) of that, the medium noise also corresponded to this and it has reduced it about 40%. In the recording density field which evaluated the reproduction output, an example 3 and the example 3 of comparison are of the same grade, and S/N's of a magnetic-recording medium have improved a decreased part of a medium noise. When it included in the magnetic disk unit and the conditions of track-recording-density 225kBPI and track density 9.8kTPI estimated record reproducing characteristics by the magnetoresistance-effect type magnetic head, compared with it of the example 3 of comparison, the magnetic-recording medium of an example 3 had 1.4 times higher S/N, and fulfilled enough the equipment specification which is 2.2 gigabits per 1 square inch of field recording density. On the other hand, S/Ns ran short and it

has not been satisfied [with the medium of the example 3 of comparison] of equipment specification.
[0053] The magnetic-recording medium was produced with the same film composition as the <example 4> example 1. The deposit which becomes both sides of the substrate with the outer diameter of 95mm, a bore [of 25mm], and a thickness of 0.8mm of 96wt%aluminum-4wt%Mg from 88wt%nickel-12wt%P was formed so that it might be thin to 13 micrometers. The front face of this substrate was ground flat and smooth until Ra was set to 2nm in surface center line average coarseness using the wrapping machine, and it dried to washing and the pan. Then, the texture of an approximate circle hoop direction was formed in the substrate front face using the tape polishing machine (it indicates to JP,62-262227,A) by pushing a polish tape against the both sides of a disk side under existence of an abrasive grain, rotating a substrate through a contact roll. Furthermore, dirt, such as an abrasive material adhering to the substrate, was washed, and it removed, and dried.
[0054] Thus, on the processed substrate, the carbon protective coat with a thickness of 10nm was further formed [the 2nd ground film which consists of a 85at%Cr-20at%Ti alloy with a thickness of 20nm the 1st ground film which consists of a 60at%Co-30at%Cr-10at%Ta alloy with a thickness of 20nm] for the 72at%Co-20at%Cr-8at%Pt alloy magnetic film with a thickness of 20nm. Membranes were formed in baton 9 seconds with the film formation equipment used in the example 1. All argon (Ar) gas pressure at the time of formation of each film was set to 5mTorr(s). The oxygen tension of the main chamber under membrane formation was about 1x10-9 (Torr).
[0055] The 1st ground film was formed in the state where a substrate is not heated at the 1st ground film formation room, it was heated to 270 degrees C at the lamp heater by the heat chamber, was **(ed) for 3 seconds after that at the oxidization room in the atmosphere of pressure 4mTorr (quantity-of-gas-flow 8sccm) of 98%Ar-2%O2 mixed gas, and formed each film on it. This is equivalent to 4mTorrx0.02x3 second =2.4x10-4 power (Torr and second) by the above-mentioned PO2 and t. After forming to the above-mentioned carbon protective coat, what diluted the material of a perfluoroalkyl polyether system with fluorocarbon material was applied as lubricating film.
[0056] Moreover, even if it does not prepare especially an oxidization room like an above-mentioned example, the detailed growth nucleus by above-mentioned oxidization can form, and the same effect as an above-mentioned example is acquired with film formation equipment with long time until ultimate vacuum forms two ground films after 1st ground film formation compared with the film formation equipment which used for the example of this invention like bad film formation equipment with large oxygen tension, or the equipment which carries out film formation simultaneous to two or more substrates.
[0057] The magnetic-recording medium was produced with the same film composition as the <example 5> example 1. The alumino silicate glass to which the chemical strengthening of the 2.5inch type was carried out was used for the substrate. The carbon protective coat with a thickness of 10nm was further formed [the 2nd ground film which consists of a 85at%Cr-15at%Ti alloy with a thickness of 20nm the 1st ground film which moreover consists of a 60at%Co-30at%Cr-10at%Zr alloy with a thickness of 25nm] for the 75at%Co-19at%Cr-6at%Pt alloy magnetic film with a thickness of 20nm. As film formation equipment, membranes were formed in baton 60 seconds using the equipment which performs each film formation simultaneously to two or more substrates held on the pallet. All argon (Ar) gas pressure at the time of formation of each film was set to 6mTorr(s). The oxygen tension of each membrane formation room under membrane formation was about 1x10-8 (Torr).
[0058] The 1st ground film was formed in the state where a substrate is not heated, next, was heated to 270 degrees C at the lamp heater by the heat chamber, and formed each film on it after that. This is equivalent to about 2x10-6 (Torr and second) by the above-mentioned PO2 and t. After forming to the above-mentioned carbon protective coat, what diluted the material of a perfluoroalkyl polyether system with fluorocarbon material was applied as lubricating film.
[0059] About the above example and example of comparison, each above-mentioned evaluation result is collectively shown in Table 2.
[0060]
[Table 2]

表 2

	第1下地膜	PO2・t (Torr・sec)	v・Isb ($x10^{-15}$ emu)	Hc (Oe)	Br・t (G・μm)
実施例1	60at%Co-30at%Cr-10at%Zr	$1.5x10^{-4}$	1.05	2170	88.8
比較例1	同 上	$3.2x10^{-7}$	2.24	1850	87.0
実施例2	62at%Co-30at%Cr-8at%Ta	$2.4x10^{-4}$	0.98	2640	85.3
比較例2	同 上	$2.3x10^{-8}$	1.81	2430	84.3
実施例3	85at%Cr-15at%Zr	$1.3x10^{-4}$	0.89	2680	69.3
比較例3	同 上	$2.2x10^{-8}$	1.44	2460	66.5
実施例4	60at%Co-30at%Cr-10at%Ta	$2.4x10^{-4}$	0.87	2890	78.3
実施例5	60at%Co-30at%Cr-10at%Zr	$2.0x10^{-6}$	1.12	2090	87.6

this invention -- amorphousness -- or -- it -- being near -- a microcrystal -- structure -- Co -- an alloy -- having used -- the -- one -- a ground -- a film -- it is -- Co -- an alloy -- a film -- a top -- the above -- an oxidizing atmosphere -- having **(ed) -- after -- the -- two -- a ground -- a film -- nothing -- direct -- a magnetic film -- having formed -- a case -- orientation with a strong (00. 1) magnetic film -- having been shown . This is suitable for the vertical-magnetic-recording medium which records magnetization perpendicularly to a film surface, although the c axis of Co alloy crystal of a magnetic layer is the suitable orientation and cannot use it perpendicularly as a magnetic-recording medium within a field to a film surface.

[0061]

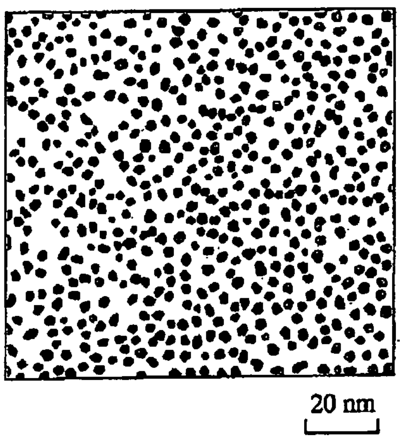
[Effect of the Invention] The magnetic-recording medium of this invention had effects, such as reduction of a medium noise, and coercive force increase. According to the manufacture method of the magnetic-recording medium of this invention, the above magnetic-recording media can be manufactured easily. Moreover, the magnetic storage using the magnetic-recording medium of this invention has high recording density.

[Translation done.]

DRAWINGS

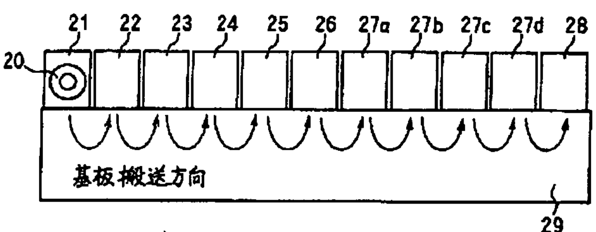
[Drawing 1]

図 1



[Drawing 2]

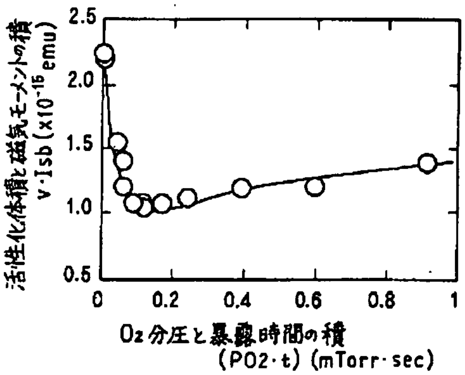
図2



20…基板
21…仕込み室
22…第1下地膜形成室
23…加熱室
24…酸化室
25…第2下地膜形成室
26…磁性膜形成室
27a,27b,27c,27d…保護膜形成室
28…取り出し室
29…メインチャンバ

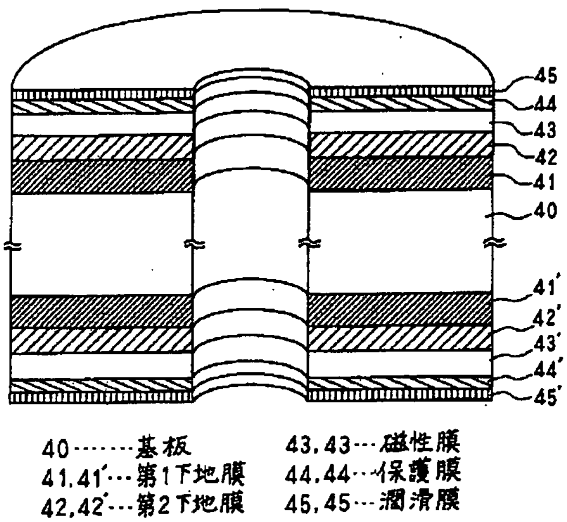
[Drawing 3]

図3



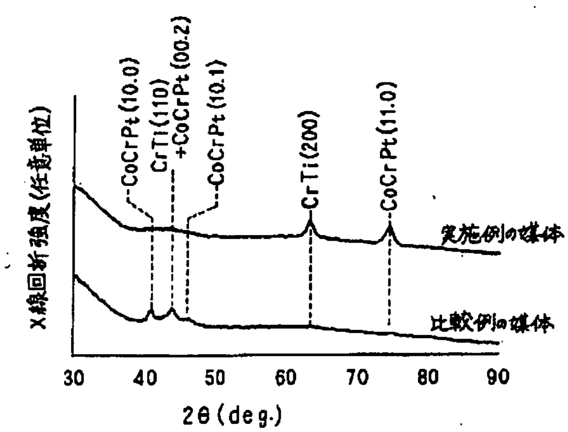
[Drawing 4]

図4



[Drawing 5]

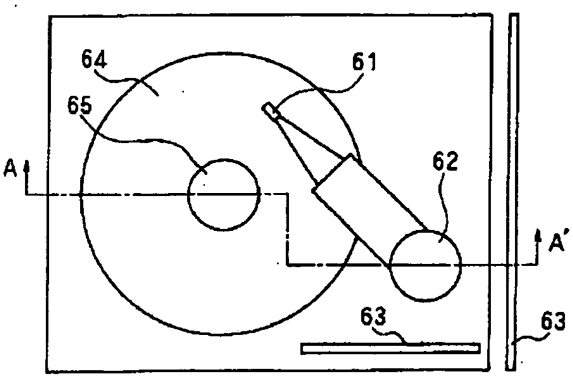
図5



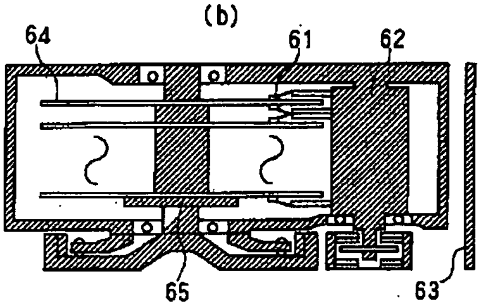
[Drawing 6]

図6

(a)



(b)



61…磁気ヘッド
62…磁気ヘッド駆動部
63…記録再生信号処理系
64…磁気記録媒体
65…駆動部

[Translation done.]